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## EVOLUTION IN THE VEGETABLE KINGDOM.

BY LESTER F. WARD, A.M.

THE law of biologic evolution (for it is no longer a mere "doctrine") may be regarded as fairly established, no large and respectable body of scientific men being any longer found to oppose it when stated in its most general form, while difference of opinion and discussion have narrowed down to the more special aspects and minor details. In the animal kingdom, where organization is generally so high and structure so definite, great progress has been made in discovering the particular lines along which development has taken place and something like a true genealogy of the existing types has been worked out. The law of phylogeny is abundantly established by palæontology and surprisingly confirmed by embryological ontogeny.

In the vegetable kingdom this last important class of evidence is almost wholly wanting, and palæontological evidence, owing to the lower structural rank of plants, is far less complete and convincing than in the animal.

It is proposed in this article briefly to inquire what vegetable palæontology has to present in favor of evolution in plants. The subject may be considered under three somewhat distinct points of view, the historical, the geological and the botanical.

### I. HISTORICAL VIEW.

It is a common observation that botany is far behind zoölogy in supporting advanced biological theories. This is still more strikingly true of the study of extinct than of that of living forms, for not only were the ancients wholly unacquainted with any form of vegetable petrification, although familiar with fossil shells,

madrepores and other animal remains, but when at last the era of science dawned toward the close of the eighteenth century Blumenbach had for many years been sounding the key-note of palæontological truth in the animal kingdom before Schlotheim took up the refrain in favor of plants.

When we consider the present state of knowledge respecting the geological strata of the earth's crust, we can scarcely realize that but two generations ago comparatively nothing was known on this subject. Geology was not yet born. The investigators of the last century were really not discussing the geologic age of fossil remains. With those who studied fossil plants the assumption was universal that they were plants that grew somewhere in the world only a few thousand years ago at most, plants such as either grew then in the countries where their remains were found or in other countries from which they had been brought by one agency or another, generally that of the Flood, or else, as some finally conceived, had been destroyed by these agencies, so as to have no exact living representatives.

In the year 1804 appeared Baron von Schlotheim's "Flora der Vorwelt," as it is now universally quoted, although the author himself merely entitled it a "description of remarkable plant impressions and petrifications—a contribution to the flora of the former (or primeval) world." To us this seems modest enough, but in view of the history of palæontology, the second part of this title amounted to a bold declaration, and accordingly we find him defending it in his introduction by these words: "The petrifications which so early engaged the attention of investigators, and which, without doubt, afforded one of the first incentives to the founding of mineral collections and to the earnest study of mineralogy and geology, have, as is well known, since Walch began to arrange them systematically, been for a long time, as well in as out of Germany, almost wholly neglected. They were content to regard them as incontestable proofs of the Deluge, which closed all further investigation until they were at last compelled to explain their occurrence through other great natural operations which had probably been going on earlier and more universally than the flood described in the Bible, and influencing the formation of the upper strata of the earth's crust; and more recent observations and investigations have even led us to the very probable supposition that *they may be the remains of an*

*earlier so-called pre-Adamitic creation, the originals of which are now no longer to be found.* \* \* \* In the continued investigation of this subject this opinion, with certain restrictions, has in fact gained a high degree of probability with the author of the present work, so that he ventures to announce his treatise as a contribution to the flora of the ancient world (Vorwelt). Since its introduction by Schlotheim this expression, "Flora der Vorwelt," has been applied to nearly all the German works on fossil plants, and "Beiträge zur Flora der Vorwelt" still continue to appear.

This work was followed, though sixteen years later, by his "Petrefactenkunde," and also by Count Sternberg's important "attempt at a geognostico-botanical presentation of the flora of the ancient world." These men were the pioneers of vegetable palæontology. It was reserved for Adolphe Brongniart to become its true founder. Brongniart's paper on the classification and distribution of fossil plants, which was published in the memoirs of the Paris Museum of Natural History in 1822, showed that he had already been some time at work, and after six years of nearly complete silence he at length came forward, in 1828, with his epoch-making works on the history of fossil plants—the "Prodrome" and the "Histoire des végétaux fossiles"—which, taken together as was the design, form the solid basis upon which the science has been erected.

Brongniart's fundamental conception was, that fossil plants were none the less plants, and that so fast as they really became known they should be placed in their proper position in the vegetable series and made to form an integral part of the science of botany. In his classification he therefore had due respect for the natural system as then understood, but he nevertheless felt that geognostic considerations must be taken into the account, and he saw with almost prophetic vision that in passing up through the geologic series higher and higher forms of vegetable life presented themselves. Although unable to understand the complete continuity in the series, as modern evolution postulates, and although affected by the Cuvierian idea of successive destructions and re-creations, still he insisted that each successive creation was superior to the one it had replaced, and that there had thus been, as it were, a steady progress from the lowest to the highest forms of vegetation. He divided the geologic series into

four great periods, the first extending through the Carboniferous and corresponding to the modern Palæozoic, the second embracing the Grès bigarré, or Buntersandstein, only, the third seeming to include the rest of the Trias, the Jurassic, and the Cretaceous, and the fourth completing the series. The table which he gives on page 219 of the "Prodrome" is designed to show the development of the higher types of vegetation in successively higher strata, and in discussing it he remarks that "in the first period there exist hardly anything but cryptogams, plants having a more simple structure than that of the following classes. In the second period the number of the two following classes becomes proportionately greater. During the third period it is the gymnosperms which specially predominate. This class of plants may be considered *intermediate between the cryptogams and the true phanerogams* [dicotyledons] which preponderate during the fourth period." The words italicized in the liberal translation here made are scarcely less than a prophecy, and one whose fulfillment is only now being tardily granted by systematic botanists.

As the result of his prolonged studies, Brongniart finally arrived at the following remarkable classification of plants, as drawn up on page 11 of the "Prodrome" and repeated on page 20 of the "Histoire:"

- I. Agams.
- II. Cellular cryptogams.
- III. Vascular cryptogams.
- IV. Gymnospermous phanerogams.
- V. Monocotyledonous angiospermous phanerogams.
- VI. Dicotyledonous angiospermous phanerogams.

In the present state of botanical science Brongniart's "agams" would probably all be relegated to his second group, or cellular cryptogams, but in other respects this classification is preëminently sound, and seems likely to be vindicated by the future progress of science.

It will thus be seen that Brongniart founded the science of vegetable palæontology firmly upon the law of progressive development, and there can be little doubt that if his influence could have been felt by botanists as it was by vegetable palæontologists in general, botany might have advanced *pari passu* with zoölogy. But Brongniart was far in advance of his time, and his views were destined to meet with violent opposition. His method was, with

few exceptions, adopted by subsequent palæo-botanists but never by botanists proper.

The most powerful antagonism to this effort of Brongniart to confirm Lamarckian principles from the phytologic side thirty-one years before the appearance of Darwin's "Origin of Species" was offered by the eminent English botanist, Dr. John Lindley, who found a fitting occasion to meet the great French palæontologist on his own ground while engaged with William Hutton in the preparation of their "Fossil Flora of Great Britain," 1831-'37. Of this truly great work we are here concerned only with certain discussions which were directed against the then infant doctrine of biologic evolution in the vegetable kingdom, and which were not only marked with great acrimony, but were allowed to influence and to warp the classification adopted by the authors into forms which even to botanists now appear ridiculous. The introductory remarks in the first volume, as well as much of the general discussion throughout the work, are characterized by a most astonishing and apparently willful ignorance of the true principles of palæo-phytology as they were set forth by Brongniart, Sternberg and even Schlotheim, and which are now universally accepted.

One of Dr. Lindley's remarkable aberrations was the pertinacity with which he contended for the existence of cactaceous and euphorbiaceous plants in the coal measures. It is true that Parkinson had seen a fancied resemblance between certain stems and those of large cacti, and similar guesses had been made by Volkmann, Walch and other authors of the eighteenth century, when it was supposed that the counterpart of every fossil plant must be found in the living flora, but all these imaginings had been long since laid aside only to be revived by the leading botanist of Europe.

The theory of a former tropical climate in England and on the continent of Europe was assailed, the existence of tree-ferns in the Carboniferous was denied, the relation of the Calamitæ to the Equisetaceæ questioned, and many other tolerably well established generalizations were remanded to the domain of doubt and discussion.

The true secret of this sweeping skepticism is, however, not far to seek. It is found in the more general denial, which was finally made, of the conclusion to which the acceptance of these

rejected theories would naturally lead and had actually led M. Brongniart and others. The authors say: "Of a still more questionable character is the theory of *progressive development*, as applied to the state of vegetation in successive ages. In the vegetable kingdom it cannot be conceded that any satisfactory evidence has yet been produced upon the subject; on the contrary, the few data that exist appear to prove exactly the contrary." All the denials and assertions made in the work opposed to Brongniart's teachings are made to support this view. The existence of Cactaceæ, Euphorbiaceæ and other dicotyledons in the Carboniferous would negative development; the admission of a former tropical climate was a strong argument for the nebular hypothesis as well as for geologic progress; tree-ferns would argue such a former tropical climate; if Calamites could be shown to be a Juncus, a higher type would be found in Palæozoic strata than Brongniart believed to occur. Still another good point was thought to be gained by proving what is now admitted, viz., that coniferous plants occur in the coal. All botanists then held, as many still hold, that the gymnosperms were a subclass of the dicotyledons, coördinate with the dicotyledonous angiosperms. But, curiously enough, Brongniart had forestalled this argument by making the gymnosperms of lower type, intermediate between the cryptogams and the angiospermous phanerogams. By a special insight, characteristic of true scientific genius, he had used their lower geological position as a proof of their lower organization, *i. e.*, had postulated evolution as an aid to organic research—a method which is now becoming quite common, although unsafe except in the hands of a master.

Dr. Lindley laid much stress upon the fact "that no trace of any glumaceous plant has been met with even in the latest Tertiary rocks," thus frèely employing the fallacy which he elsewhere warns others to avoid, that because a class of plants has not been found, therefore it did not exist at a given geologic epoch. But to cut off the possibility of a reply to the position he takes he finally declares that "supposing that sigillarias and stigmarias could really be shown to be cryptogamic plants, and that it could be absolutely demonstrated that neither Coniferæ nor any other dicotyledonous plants existed in the first geological age of land plants, still the theory of progressive development would be untenable, because it would be necessary to show that

monocotyledons are inferior in dignity, or, to use a more intelligible expression, are less perfectly formed than dicotyledons. So far is this from being the case that if exact equality of the two classes were not admitted, it would be a question whether monocotyledons are not the more highly organized of the two; whether palms are not of greater dignity than oaks, and *Cerealia* than nettles." Teleologic and anthropocentric reasoning like this pervades all the discussions in this work and vitiates the scientific deductions. The elaborate experiment that Dr. Lindley made and described in the first dozen pages of the third volume, was obviously animated by the same spirit of uncompromising hostility to the development hypothesis. By showing that the higher types of plants when long immersed in water are earlier decomposed than ferns, conifers and palms, he thought he had demonstrated that the reason why we find no dicotyledons in the Carboniferous is simply because they had not resisted, and from their nature could not resist the destructive agencies to be overcome in the process of petrification. One could wish that he might behold the four thousand species of fossil dicotyledons now known, and realize how vain had been his experiment as well as all his theorizing!

It is such resistance as this, coupled with the power of the Jussæan method, that has retarded the progress of correct ideas respecting the development of plant life. Systems of classification have been chiefly modeled after those of the early founders. The text books of botany still generally invert the order and begin with the phænogams, although this is doubtless merely intended to facilitate study, and does not at all imply that our leading botanists believe this to have been the order in which plants have developed. This inversion of the order, however, shows how completely the notion of development is ignored in modern botany, and the system throughout rests upon the evidence furnished by the organs of the plants as they are understood. Nevertheless, it is proper to say that at the present time quite a large body of the most thorough students of vegetal embryology and histology, chiefly in Germany, have rejected much of the modern system of botanical classification, and especially that which concerns the position of the gymnosperms. They prove in the most satisfactory manner that these plants constitute a lower type than any of the remaining phanerogams, and they



also find that in their reproductive organs they form a more or less natural transition from the cryptogams to the phænogams, between which they place them. This result is most gratifying to the palæo-botanist, for nearly all works on fossil plants give the gymnosperms this position at the base of the phænogamic series, so sagaciously assigned to them by Brongniart. They have been compelled to do this in the face of the prevailing botanical systems, because this is the position which they are found to occupy in the ascending strata of the earth's crust. It is astonishing that botanists could have remained so indifferent to such a weighty fact, and it is certainly most instructive to find the geological record, so long unheeded, confirmed at last by the facts revealed in living plants. There is no evidence that those who have thus confirmed it were in the least influenced by it, since Sachs and Caruel are as silent respecting palæontology as De Candolle or Bentham.

The founders and perfecters of the prevailing system of botanical classification have not been influenced to any marked degree by the idea of development in vegetable life. Few of the earlier ones had ever heard of development, except at least as a visionary theory. This system had become established long before the doctrine of the fixity of species had received a shock, for although Lamarck, himself a botanist, had sown the seed of its ultimate overthrow, still it required half a century for this seed to germinate, and it was during this half century that the Jussian system was supplanting the Linnæan and gaining a firm foothold.

Shaking off, for the time being, all fixed allegiance to any system, let us glance for a moment at the lesson which vegetable palæontology now teaches upon the subject of development.

*(To be continued.)*

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## ON THE VERTICAL RANGE OF CERTAIN FOSSIL SPECIES IN PENNSYLVANIA AND NEW YORK.

BY PROFESSOR E. W. CLAYPOLE.

THE Second Geological Survey of Pennsylvania has recently published a report on Montour, Columbia and several other counties, written by Professor I. C. White, of the University of West Virginia. While engaged in the work Professor White requested the writer to determine for him the fossils which he